JSC TOXICOLOGY AND ENVIRONMENTAL CHEMISTRY GROUP

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SUBJECT: Toxicological Assessment of ISS Air and Water Quality: June 2, 2017- September 2, 2017 (Increment 52), Including JEM CBEF Exhaust Fan Contingency and SpX-11 and SpX-12 Ingress Reports

SUMMARY: Based on these data, air quality was acceptable on ISS for this period and potable water remains acceptable for crew consumption.

AIR QUALITY

Six archive air samples were collected in mini grab sample containers (mGSCs) on ISS during Increment 52. Four of these samples were collected as part of routine monitoring in the US Lab, Japanese Pressurized Module (JPM), and Russian Service Module (SM). The fifth sample was collected as part of an investigation associated with a crew report of pungent odor emanating from the JAXA rodent habitat. The sixth sample was collected as part of SpX-11 first ingress operations. An additional sample was planned as part of Space-X 12 (SpX-12) first entry, but upon receipt in the laboratory it was determined that the sample was not collected. A total of four pairs of passive-diffusion formaldehyde badges were also deployed in the Lab and SM on 6/27/2017 and 8/8/2017. Aside from the SpX-11 ingress mGSC sample, which returned on SpX-11, all mGSC samples and formaldehyde badges were returned on SpX-12. A summary of the analytical results from the samples is provided in Table 1.

Table 1. Analytical summary of ISS air analyses

Sample Location	Sample Date	Freon 218 (mg/m^3)	Alcohols[a] (mg/m^3)	T-Value[b] (units)	CO_2 (mg/m^3)	Formaldehyde ($\mu g/m^3$)
SpX-11 Ingress	6/5/2017	32	4.0	0.2 (0.1)	3100	-
Lab	6/27/2017	55	4.9	0.2	4900	29[e]
SM	6/27/2017	61	5.7	0.2	6100	21[e]
Lab	8/8/2017	96	5.9	0.2	6300	39[e]
JPM	8/8/2017	95	6.2	0.2	6000	-
SM	8/8/2017	-	-	-	-	22[e]
JEM CBEF Contingency	8/24/2017	87	5.7	0.2	6300	-
Guideline		---	*<5*	*<1[c]*	*<7100[d]*	*<120*

[a]Includes acetone
[b]Sum of the ratios of the measured concentration and the corresponding 180-day SMAC for each compound, excluding CO_2; parentheses indicate value based on 7-day SMACs and applicable to first ingress
[c]T-value <1 used to evaluate routine monthly sampling; <3 used to evaluate first ingress
[d]CO_2 to be controlled as low as reasonably achievable (ALARA) – currently 3 mmHg (7100 mg/m^3) or lower
[e]Average from pair of formaldehyde badges

Data tables containing measured concentrations and corresponding T-values based on appropriate Spacecraft Maximum Allowable Concentrations (SMACs) for compounds present at levels above the laboratory reporting limit are attached to this report. Complete data tables including compounds assessed but not detected are available upon request. The mean relative recoveries of the three surrogate standards

from the SpX-12 return mGSC samples were as follows: ^{13}C-acetone, 100±9%; fluorobenzene-d_5, 101±7%; and chlorobenzene-d_5, 103±10%. For the passive-diffusion formaldehyde badges, positive control recoveries (1 in-flight and 2 lab controls) were 95, 71, and 106%, respectively.

Automated sampling sessions are scheduled on the Air Quality Monitors (AQMs) every 73 hours, which results in 2-3 sampling sessions per unit per week. Monthly average concentrations as well as the Increment average concentrations for compounds measured on the AQMs are presented in Table 2.

Table 2. Average monthly concentrations (mg/m^3) of AQM target compounds

Compound	June Average	July Average	August Average	Increment Average
2-Propanol	0.40	0.17	TRACE	0.29
Acetone	0.29	0.30	0.17	0.25
Acrolein	ND	ND	ND	ND
Benzene	ND	ND	ND	ND
1,2-Dichloroethane	ND	ND	ND	ND
Decamethylcyclopentasiloxane#	0.15	0.14	0.20	0.16
Hexanal	ND	ND	ND	ND
Hexane	ND	ND	ND	ND
m,p-Xylenes#	ND	ND	TRACE	ND
Methanol	0.27	0.27	0.26	0.27
o-Xylene#	0.03	0.03	0.04	0.03
Octamethylcylcotetrasiloxane#	TRACE	TRACE	TRACE	TRACE
Toluene#	TRACE	TRACE	0.03	TRACE
2-Butanone	ND	ND	ND	ND
Acetaldehyde	0.11	0.12	TRACE	0.11
Dichloromethane	ND	ND	ND	ND
Ethanol	3.35	2.24	4.86	3.48
Ethyl Acetate	ND	ND	TRACE	ND
Hexamethycyclotrisiloxane#	0.05	0.06	0.06	0.06
n-Butanol	0.05	0.05	0.07	0.06
Trimethylsilanol	0.10	0.12	0.14	0.12

Obtained from prime unit
ND: Not detected; <MDL (Minimum Detection Limit)
TRACE= >MDL, <MQL (Minimum Quantification Limit)

Toxicological Evaluation of ISS Air Quality

Routine air quality monitoring is performed in-flight using the AQMs. Archive air samples (mGSCs and formaldehyde badges) are collected during each Increment and returned for analysis in the Toxicology and Environmental Chemistry (TEC) Air Quality Laboratory. Data from the ground analyses complement the in-flight data and provide a more complete understanding of air quality on the ISS. The routine archive samples for this Increment that returned on SpX-12 confirmed air quality was acceptable during this time frame. **All measured values for routine samples (mGSC and AQM) met T-value guideline criteria (T < 1), indicating no concern for crew health.** The average, rounded T-value calculated from the Increment 52 mGSC samples was 0.2 (Figure 1). The average, rounded T-value calculated from the AQM data (Figure 2) was slightly lower (0.1 units), but still showed close agreement with the mGSC value. Overall, the reported concentrations for the compounds detected are consistent with levels detected since installation of the Node 1 carbon filters in May 2015.

The nominal mGSC samples contained a CO_2 concentration below the Increment limit documented in Chit 14468, which requests that the 24 hour average concentration not exceed 3.0 mmHg (7100 mg/m^3). While mGSC CO_2 sampling provides a snap-shot of the CO_2 concentration, the major constituent analyzer (MCA)

routinely monitors CO_2 levels in the US segment. For this reason, data from the MCA is better suited for evaluation of short and long-term trends in CO_2. The MCA data concentrations fluctuate as a result of multiple factors including the number of crew on ISS, current scrubbing capability, and processes and activities that generate CO_2. The average 24 hr CO_2 concentration was maintained near 2.0 mmHg throughout June and July, then increased to approximately 3.0 mmHg during August due to docking of 51S (increase from 3 to 6 crew). MetOx regeneration caused brief excursions above the 3.0 mmHg Increment limit on 6/9, 6/16, 6/22, 7/11, and 7/12. During August, additional measures, including use of LiOH canisters on the Russian segment, were taken to reduce and maintain average levels at or below 3 mmHg. Overall, CO_2 concentrations were well controlled throughout the Increment.

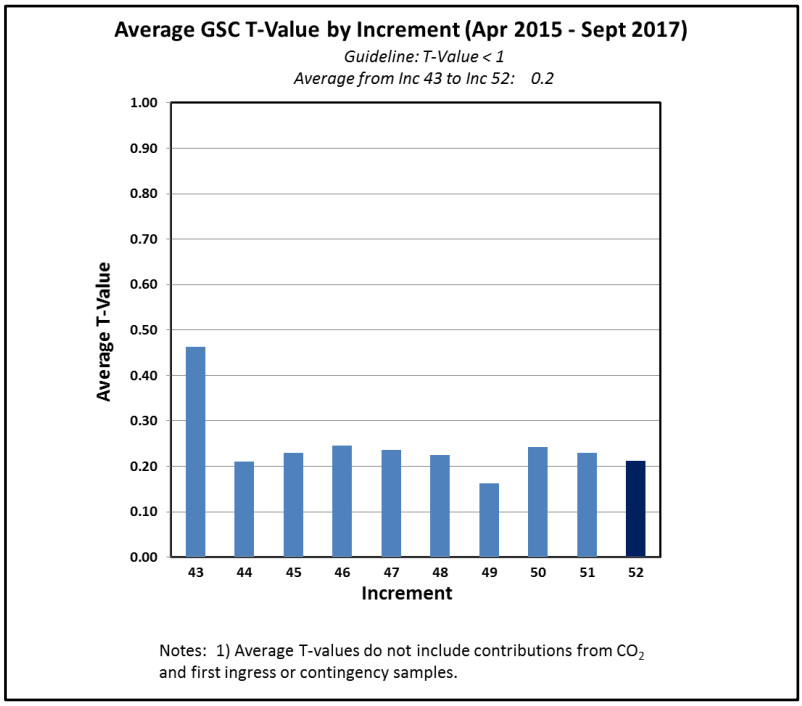

Figure 1. GSC T-values

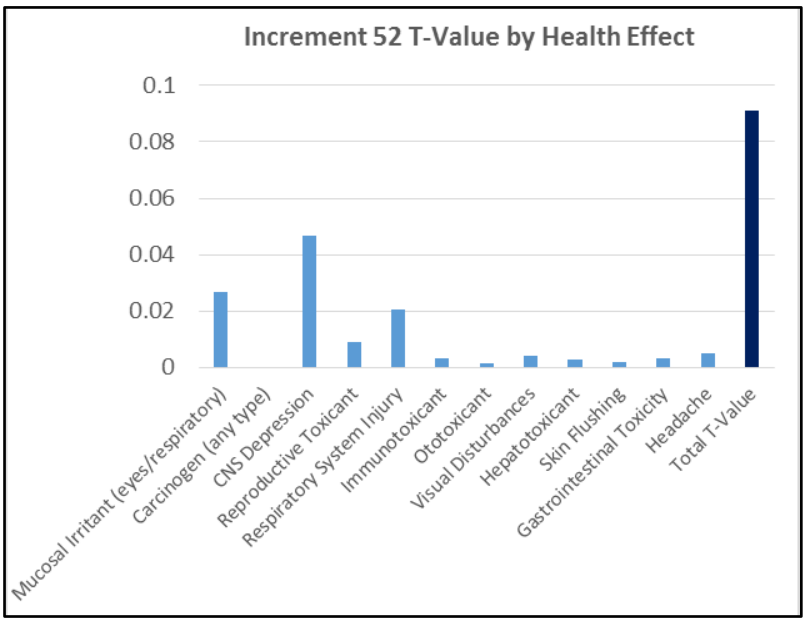

Figure 2. AQM T-values

Alcohol values in most routine samples continued to exceed the guideline of <5 mg/m3, which is intended to protect the water recovery system from risk of overloading. These levels are primarily due to ethanol in the ISS atmosphere. AQM results for ethanol were lower than the levels measured in the mGSCs, with an Increment average of 3.48 mg/m^3. This is similar to the average concentration measured during Increment 51. This difference between the measured values may be due to temporal and spatial differences between the AQMs and mGSC sample points. Importantly, ethanol levels during the entire Increment did not present a risk for crew health. From 6/27 to 8/8, octafluoropropane (Freon 218) levels increased from 55 mg/m^3 in the US Lab and 61 mg/m^3 in the Russian Service Module to 96 mg/m^3 in the US Lab and 95 mg/m^3 in the JPM. While not a toxicological concern, this does indicate a small octafluoropropane leak occurred. Formaldehyde levels in the US Lab (shown in Table 1 and Figure 3) are generally consistent with historic levels and remain below the SMAC of 120 µg/m^3.

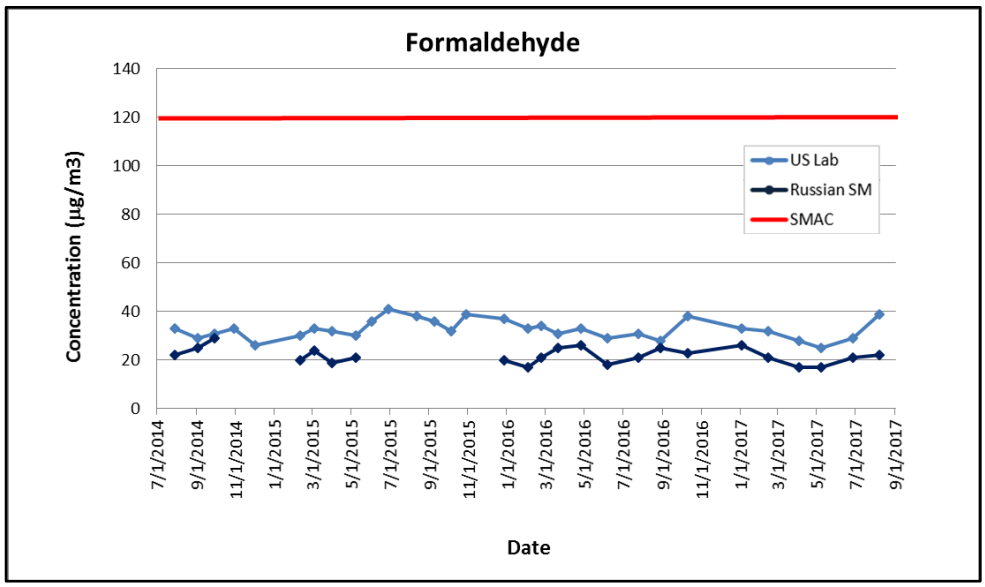

Figure 3. Formaldehyde trending in ISS air.

SpX-11 Ingress

A first entry sample was collected upon ingress into SpX-11 on 6/5/2017 six minutes after hatch opening. The concentration of octafluoropropane, a marker for ISS air dilution of first entry samples, was 32 mg/m^3. This compound was measured at an average of 75 mg/m^3 in the 5/8 nominal samples and at an average of 58 mg/m^3 in the 6/27 nominal samples. Carbon dioxide was detected in the ingress sample at a concentration of 3100 mg/m^3. At the time this sample was collected, the average concentration of CO_2 in Node 3 reported by the MCA was 1.9 mmHg (~4500 mg/m^3). These results indicate that approximately 60-70% mixing occurred, although octafluoropropane comparison is a more reliable measurement of dilution since CO_2 contribution from the sample collector's exhaled breath may also occur. The total T-value (minus CO_2) was 0.1, which was well below the limit of 3.0 units and similar to other Space-X ingress results (SpX-10: 0.12; SpX-9: 0.34; SpX-8: 0.07; SpX-6: 0.11). The primary contributors were carbon monoxide (0.03 mg/m^3) and acetaldehyde (0.03 mg/m^3). If we account for a maximum of 70% dilution, exposure to SpX-11 vehicle air would have posed no risk to crew health.

JEM CEBF Odor Contingency Sample

The JAXA Rodent Research payload arrived on SpX-12, which berthed on 8/16/2017. Rodent habitats were housed in the Cell Biology Experiment Facility (CBEF) in the JEM. On 8/24 (GMT 236) crew reported an unusually pungent rodent-related odor in the vicinity of the CBEF. A contingency mGSC sample was collected in front of the JEM Micro-G CBEF Exhaust fan to ensure there were no compounds present at

levels of concern for effects other than odor. The filter, which was not adequate to contain the odor, was reconfigured on 8/31 to increase efficiency and crew reported that the odor was mitigated as a result. Concentrations of target compounds in the contingency sample did not differ substantially from background ISS levels. Compounds expected to be generated by the rodents in the greatest abundance, such as ammonia and trimethylamine, would likely be lost due to adsorption on the walls of the mGSC. As such, archival sampling is not an ideal method to monitor these compounds. Ammonia can be qualitatively monitored with the AQMs, but this compound was not substantially different than the background near the time of the contingency sampling. However, it should be noted that the AQMs were also not located near the CBEF.

WATER QUALITY

Seven archive water samples were collected from the US segment during Increment 52. These consisted of three potable water samples from the Ambient and Hot legs of the US Potable Water Dispenser (PWD), as well as samples of US condensate, wastewater, and effluents from the Multifiltration (MF) beds in the Water Processor Assembly (WPA). Samples were returned on SpX-12 and Soyuz 50 (50S), as indicated in Table 3. Complete data tables with results for all measured parameters can be found in report 2017-TEC-WQ-004. A summary of select analytical results is provided in Table 3. Expanded summary tables containing organic carbon recoveries and results for all analytes present at concentrations above reporting limits are included as attachments to this report.

Table 3. Analytical Summary of ISS Water Analyses

Return Mission	Sample Location	Sample Date	TOC (mg/L)	DMSD (mg/L)	Conductivity (µS/cm)	Total Iodine (mg/L)
SpX-12	PWD (Ambient)	7/6/2017	0.96	2.7	1	<0.05
50S	PWD (Ambient)	8/8/2017	1.04	2.4	2	<0.05
50S	PWD (Hot)	8/23/2017	1.01	1.9	2	<0.05
SpX-12	MF Bed Effluent	8/9/2017	23.2	17.0	18	NA
SpX-12	MF Bed Effluent	8/9/2017	19.1	19.0	14	NA
SpX-12	Wastewater	8/11/2017	41.9	17.0	122	NA
SpX-12	US Condensate	8/8/2017	113	65.0	360	NA

Toxicological Evaluation of ISS Water Quality: Routine water quality monitoring is performed in-flight using the total organic carbon analyzer (TOCA). Results from these analyses provide a general indication of overall water quality. Archive water samples are collected during each Increment and returned for comprehensive analysis in ground laboratories. Data from the ground analyses complement the in-flight data and provide a more complete understanding of water quality on the ISS.

Potable Water

Concentrations of all chemicals detected in the potable water samples met the requirements listed in SSP 41000, *System Specification for the International Space Station* and the Medical Operations Requirement Document (MORD). Total organic carbon (TOC) concentrations from in-flight (PWD TOC and WPA TOC) and ground analyses (Archive TOC) performed between September 2016 and September 2017 are shown in Figure 4. The TOC concentration in the water produced by WPA remained elevated during Increment 52 (primarily due to DMSD), but measured concentrations were well below both the U.S. Segment Specification (3000 µg/L) and the 100-day Spacecraft Water Exposure Guideline (SWEG) (5000 µg/L). The TOC concentration in the U.S. archive samples (Archive TOC) were 958 µg/L for the Ambient sample collected on 7/6, 1040 µg/L for the Ambient sample collected on 8/8, and 1010 µg/L for the Hot sample collected on 8/23. It should be noted that all of these concentrations are higher than the concentrations measured on the same days in-flight, which may suggest reduced sensitivity of PFU2. PFU2

was installed on 6/4/2013 and is nearing its expected lifetime of five years; however, replacement of PFU2 with PFU3 is not expected to occur until PFU2 fails.

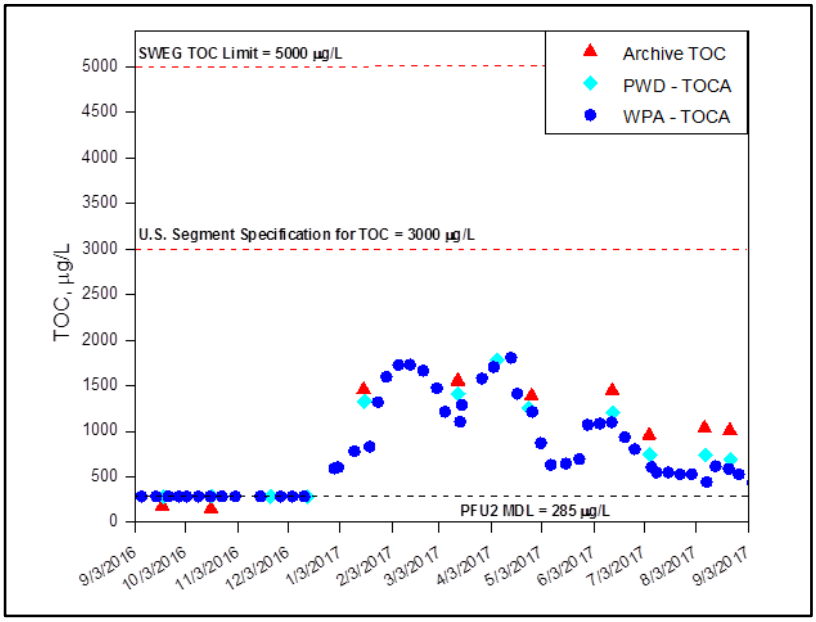

Figure 4. Total Organic Carbon (TOC) trending in US Potable Water

As mentioned, the source of the TOC in the potable samples was primarily DMSD (2.7 mg/L in 7/6 Ambient, 2.4 mg/L in 8/8 Ambient, and 1.9 mg/L in PWD Hot). Methyl sulfone, another minor contributor to the TOC, was higher (101-151 µg/L) than the historical average for both ports (56-74 µg/L), but fairly consistent with levels from samples collected over the past three years (90-140 µg/L). Silicon was also detected (0.69 - 0.81 mg/L) at levels typically seen when DMSD is present in the water. In the potable samples, nickel (4-7 µg/L) and zinc (1-2 µg/L) were found at concentrations consistent with previous samples. In the PWD Hot sample, aluminum (2 µg/L) was also detected at levels near the historical average.

Iodine is a biocide used on the US segment. It is added to the water produced by the WPA, but removed prior to crew consumption to avoid potential thyroid dysfunction. The total iodine level in the samples collected from the PWD were below the reporting limit (0.05 mg/L), indicating effective removal of iodine in water intended for consumption. For additional information regarding microbial analyses, please see the Increment 52 post-flight report issued by the JSC Environmental Microbiology Laboratory.

ECLSS Samples

The TOC level in the condensate sample collected on 8/8/2017 was 113 mg/L. This is below the historical average (164 mg/L), but higher than the concentration measured in the Increment 51 sample (48.1 mg/L). Organic compounds detected above 1 mg/L in this sample were DMSD (65 mg/L), propylene glycol (45.8 mg/L), ethanol (30.0 mg/L), acetate (9.17 mg/L), methanol (5.4 mg/L), ethylene glycol (4.25 mg/L), 2-phenoxyethanol (2.6 mg/L), benzyl alcohol (2.39 mg/L), benzoic acid (1.75 mg/L), acetone (1.71 mg/L), 2-(2-butoxyethoxy)ethanol (1.5 mg/L), and triethyl phosphate (1.4 mg/L). Although the majority of these compounds were detected at levels that are representative of recent samples (excluding Increment 51, which was exceptionally clean), the DMSD, triethyl phosphate, and propylene glycol concentrations in this sample are among the highest ever measured on ISS. Metals detected in the sample above 0.1 mg/L included zinc (5.14 mg/L) and nickel (0.619 mg/L). Traces of aluminum were also present. Manganese was detected at a higher level (63 µg/L) than in recent condensate samples, which may indicate higher surface corrosion or

air concentrations. Importantly, all of these compounds were effectively removed by the WPA as evidenced by the low or undetectable levels in the potable samples.

The TOC level in the wastewater sample collected on 8/11/2017 was 41.9 mg/L, which is close to the historical average of 46.4 mg/L and similar to the Increment 51 level. Of the organic compounds present above 1 mg/L in the sample, the concentrations of ethanol (19.2 mg/L), methanol (5.96 mg/L), and acetone (5.36 mg/L) were lower than the concentrations measured in the Increment 51 sample (ethanol: 33.6 mg/L; methanol: 9.74 mg/L; acetone: 7.82 mg/L). Similar to the condensate sample, levels of DMSD (17.0 mg/L) and propylene glycol (8.64 mg/L) were higher than what was found in the Increment 51 sample (DMSD: 12 mg/L; propylene glycol: 5.82 mg/L). Benzoic acid (1.78 mg/L) and formate (3.44 mg/L) were also detected. Metals detected at or above 0.1 mg/L included zinc (1.49 mg/L), nickel (0.236 mg/L), manganese (0.216 mg/L), and iron (0.100 mg/L). The manganese was significantly higher than recent samples. As with the condensate samples, all compounds of toxicological interest were effectively removed by the WPA.

MF Bed Samples

The MF bed samples were collected as part of an effort to determine which compounds were causing elevated conductivity readings downstream of the beds. Samples of the effluent from both beds (S/N 00016 and 00017) were collected on 8/9/2017 and returned on SpX-12. The TOC concentrations in these samples were 23.2 mg/L and 19.1 mg/L, respectively. In the S/N 00016 sample, organic compounds present at concentrations greater than 0.5 mg/L included DMSD (17.0 mg/L), ethanol (10.4 mg/L), acetate (6.34 mg/L), acetone (5.3 mg/L), propylene glycol (4.85 mg/L), methanol (4.01 mg/L), 2-propanol (1.36 mg/L), ethylene glycol (1.02 mg/L), propionate (0.964 mg/L), and 1-propanol (0.524 mg/L). The S/N 00017 sample contained DMSD (19.0 mg/L), ethanol (8.32 mg/L), acetone (6.02 mg/L), acetate (4.69 mg/L), methanol (3.8 mg/L), propylene glycol (3.64 mg/L), 2-propanol (2.44 mg/L), and ethylene glycol (1.22 mg/L). Both samples contained trace levels of nickel (16-23 µg/L) and zinc (8-11 µg/L). A trace level of copper (17 µg/L) was also detected in the S/N 00016 sample. These results indicate that acetate is the most likely cause of the elevated conductivity readings downstream of the MF beds. The presence of acetate in the effluents also suggests that DMSD is no longer being retained on the beds. Since DMSD is less tightly bound to the ion exchange resin in the MF beds than acetate, displacement of acetate by a more strongly bound species suggests that DMSD is not being retained. This is also supported by the close agreement between the DMSD concentrations measured in the wastewater sample and the effluent samples. While the contaminant load in both samples suggests that breakthrough of organic compounds that are expected to be retained by the beds is occurring, downstream processing by the WPA produces potable water that is acceptable for crew consumption.

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Enclosures

Table 1A: Analytical concentrations of compounds quantified in the mGSC returned on SpX11

Table 1B: Analytical concentrations of compounds quantified in mGSCs returned on SpX12

Table 2A: T-values corresponding to concentrations in Table 1A, based on 7-day and 180-day SMACs

Table 2B: T-values corresponding to concentrations in Table 1B, based on 180-day SMACs

Table 3: Analytical concentrations of compounds quantified in US potable water sample returned on SpX-12 and Soyuz 50

Table 4: Analytical concentrations of compounds quantified in US MF bed effluent, wastewater, and condensate samples returned on SpX-12

TABLE 1A
ANALYTICAL RESULTS OF SPACEX-11 INGRESS AIR SAMPLE

CHEMICAL CONTAMINANT	CONCENTRATION (mg/M3) AQ170140 SN2060 SpaceX-11 Ingress 06/05/17 @ 21:44 GMT
TARGET COMPOUNDS (TO-15) **	
1,1,1,2-Tetrafluoroethane (Norflurane)	0.055
Perfluoro(2-methylpentane)	0.11
Methanol	0.29
Acetaldehyde	0.12
Ethanol *	**3.2**
Acetone	0.16
2-Propanol (Isopropanol)	0.30
Methylene chloride (Dichloromethane)	0.47
Trimethylsilanol	0.055
2-Methylhexane	0.036
Octafluoropropane (Perfluoropropane) *	**32**
SPECIAL INTEREST COMPOUNDS ***	
All Special Interest Compounds were below their reporting limit	
NON-TARGET COMPOUNDS ***	
Tetradecafluorohexane	0.12
TOTAL ALCOHOLS PLUS ACETONE	**4.0**
TARGET COMPOUNDS (GC) **	
Methane	7.3
Carbon dioxide	3100
Hydrogen	1.6
Carbon monoxide	1.8
TOTAL CONCENTRATION (NON-METHANE HYDROCARBONS)	**37**
TOTAL CONCENTRATION - OFP (NON-METHANE HYDROCARBONS)	**5.0**

* GC/FID data results are in bold
** Quantified using a multi-point calibration
*** Quantified using "B" response factor except where noted;
concentrations are estimates only.
< : Value is less than the laboratory reporting limit.
OFP - Octafluoropropane

TABLE 1B
ANALYTICAL RESULTS OF SPACEX-12 RETURN

CHEMICAL CONTAMINANT	CONCENTRATION (mg/M^3)				
	AQ170184 SN2062 LAB 6/27/2017 @ 08:14 GMT	**AQ170185 SN2063 SM 6/27/2017 @ 08:17 GMT**	**AQ170186 SN2065 LAB 08/08/17 @ 10:20 GMT**	**AQ170187 SN2064 JPM 08/08/17 @ 10:22 GMT**	**AQ170189 SN2067 JEM CBEF Exhaust Fan Contingency 08/24/17 @ 14:46 GMT**
TARGET COMPOUNDS (TO-15) **					
1,1,1,2-Tetrafluoroethane (Norflurane)	0.062	0.062	<0.050	0.058	0.069
Perfluoro(2-methylpentane)	<0.10	<0.10	<0.10	<0.10	0.12
Methanol	0.41	0.50	0.43	0.45	0.44
Acetaldehyde	0.29	0.31	0.24	0.25	0.26
2-Methyl-1-propene	TRACE	TRACE	TRACE	TRACE	TRACE
Ethanol *****	**3.8**	**4.5**	**4.9**	**5.1**	**4.7**
Acetone	0.31	0.31	0.33	0.37	0.31
2-Propanol (Isopropanol)	0.35	0.27	0.14	0.19	0.18
Isoprene (2-Methyl-1,3-butadiene)	<0.025	<0.025	0.031	0.031	TRACE
Methylene chloride (Dichloromethane)	0.090	0.087	0.045	0.046	0.039
1-Propanol	0.026	0.030	0.042	0.041	0.027
Trimethylsilanol	0.081	0.073	0.11	0.13	0.13
Ethyl acetate	<0.025	<0.025	TRACE	TRACE	<0.025
1-Butanol	0.047	0.054	0.051	0.057	0.054
3-Methylhexane	0.029	0.036	0.033	0.035	0.031
Toluene	0.026	0.028	0.032	0.034	0.029
o-Xylene	<0.050	TRACE	<0.050	<0.050	TRACE
Decamethylcyclopentasiloxane	0.29	0.30	0.21	0.24	0.23
Octafluoropropane (Perfluoropropane) *	**55**	**61**	**96**	**95**	**87**
SPECIAL INTEREST COMPOUNDS ***					
All Special Interest Compounds were below their reporting limit					
NON-TARGET COMPOUNDS ***					
All Non-Target Compounds were below their reporting limit					
TOTAL ALCOHOLS PLUS ACETONE	**4.9**	**5.7**	**5.9**	**6.2**	**5.7**
TARGET COMPOUNDS (GC) **					
Methane	10	11	17	16	19
Carbon dioxide	4900	6100	6300	6000	6300
Hydrogen	2.3	2.3	3.4	3.5	4.1
Carbon monoxide	< 1.1	< 1.1	1.2	1.2	1.2
TOTAL CONCENTRATION (NON-METHANE HYDROCARBONS)	**61**	**67**	**103**	**102**	**94**
TOTAL CONCENTRATION - OFP (NON-METHANE HYDROCARBONS)	**5.8**	**6.1**	**6.8**	**6.9**	**6.5**

* GC/FID data results are in bold

** Quantified using a multi-point calibration

*** Quantified using "B" response factor except where noted; concentrations are estimates only.

TRACE: Amount detected is sufficient for compound identification only. One-half of the reporting limit was used in the Total Concentration summation.

OFP - Octafluoropropane

TABLE 2A
T-VALUES FOR SPACEX-11 INGRESS AIR SAMPLE

CHEMICAL CONTAMINANT	T-VALUE (7-d SMAC)	T-VALUE (180-d SMAC)
	AQ170140 SN2060 SpaceX-11 Ingress 06/05/17 @ 21:44 GMT	**AQ170140 SN2060 SpaceX-11 Ingress 06/05/17 @ 21:44 GMT**
TARGET COMPOUNDS (TO-15)		
1,1,1,2-Tetrafluoroethane (Norflurane)	0.00027	0.00027
Perfluoro(2-methylpentane)	0.00000	0.00000
Methanol	0.00323	0.00323
Acetaldehyde	0.03090	0.03090
Ethanol	0.00162	0.00162
Acetone	0.00314	0.00314
2-Propanol (Isopropanol)	0.00197	0.00197
Methylene chloride (Dichloromethane)	0.00950	0.04654
Trimethylsilanol	0.01380	0.01380
2-Methylhexane	0.00015	0.00303
Octafluoropropane (Perfluoropropane)	0.00037	0.00037
SPECIAL INTEREST COMPOUNDS		
All Special Interest Compounds were below their reporting limit		
NON-TARGET COMPOUNDS		
Tetradecafluorohexane	0.00000	0.00000
TARGET COMPOUNDS (GC)		
Methane	0.00208	0.00208
Carbon dioxide	0.24018	0.24018
Hydrogen	0.00477	0.00477
Carbon monoxide	0.02907	0.10772
TOTAL T-VALUE	**0.34107**	**0.45965**
TOTAL T-VALUE - CO2	**0.10089**	**0.21946**

ND : Value is less than the laboratory reporting limit.
Note: Number of decimal places in T-Values do not represent significant figures of measurements.

TABLE 2B
T-VALUES FOR SPACEX-12 RETURN

CHEMICAL CONTAMINANT	T-VALUE (180-d SMAC)				
	AQ170184 SN2062 LAB 6/27/2017 @ 08:14 GMT	**AQ170185 SN2063 SM 6/27/2017 @ 08:17 GMT**	**AQ170186 SN2065 LAB 08/08/17 @ 10:20 GMT**	**AQ170187 SN2064 JPM 08/08/17 @ 10:22 GMT**	**AQ170189 SN2067 JEM CBEF Exhaust Fan Contingency 08/24/17 @ 14:46 GMT**
TARGET COMPOUNDS (TO-15)					
1,1,1,2-Tetrafluoroethane (Norflurane)	0.00031	0.00031	ND	0.00029	0.00034
Perfluoro(2-methylpentane)	ND	ND	ND	ND	0.00000
Methanol	0.00452	0.00551	0.00475	0.00496	0.00492
Acetaldehyde	0.07279	0.07801	0.06119	0.06279	0.06617
2-Methyl-1-propene	0.00011	0.00011	0.00011	0.00011	0.00011
Ethanol	0.00191	0.00225	0.00244	0.00254	0.00233
Acetone	0.00590	0.00593	0.00625	0.00703	0.00593
2-Propanol (Isopropanol)	0.00233	0.00177	0.00095	0.00125	0.00120
Isoprene (2-Methyl-1,3-butadiene)	ND	ND	0.01030	0.01046	0.00417
Methylene chloride (Dichloromethane)	0.00903	0.00865	0.00450	0.00460	0.00388
1-Propanol	0.00026	0.00031	0.00043	0.00042	0.00028
Trimethylsilanol	0.02017	0.01817	0.02816	0.03347	0.03318
Ethyl acetate	ND	ND	0.00007	0.00007	ND
1-Butanol	0.00119	0.00135	0.00128	0.00143	0.00135
3-Methylhexane	0.00245	0.00303	0.00272	0.00289	0.00262
Toluene	0.00175	0.00187	0.00212	0.00224	0.00193
o-Xylene	ND	0.00068	ND	ND	0.00068
Decamethylcyclopentasiloxane	0.01965	0.01970	0.01418	0.01586	0.01509
Octafluoropropane (Perfluoropropane)	0.00065	0.00072	0.00113	0.00112	0.00103
SPECIAL INTEREST COMPOUNDS					
All Special Interest Compounds were below their reporting limit					
NON-TARGET COMPOUNDS					
All Non-Target Compounds were below their reporting limit					
TARGET COMPOUNDS (GC)					
Methane	0.00288	0.00314	0.00472	0.00471	0.00551
Carbon dioxide	0.38048	0.46600	0.48295	0.45938	0.48371
Hydrogen	0.00685	0.00682	0.01002	0.01029	0.01207
Carbon monoxide	0.03198	0.03198	0.07326	0.07236	0.07182
TOTAL T-VALUE	**0.56518**	**0.65631**	**0.71154**	**0.69826**	**0.71832**
TOTAL T-VALUE - CO2	**0.18470**	**0.19031**	**0.22859**	**0.23889**	**0.23461**

ND : Value is less than the laboratory reporting limit.
Note: Number of decimal places in T-Values do not represent significant figures of measurements.

Table 3: Analytical concentrations of compounds quantified in US potable water sample returned on SpX-12 and Soyuz 50

Increment					52		
Mission					SpX-12	Soyuz 50	
Sample Location					WPA PWD Ambient	WPA PWD Ambient *	WPA PWD Hot *
Sample Description		Test	Potable Water Maximum Contaminant	Maximum Contaminant	Potable Water	Potable Water	Potable Water
Sample Date		Conducted	Level	Level	7/6/2017	8/8/2017	8/23/2017
Analysis/Sample ID	Units	by	(MCL)	Source	20170919001	20170905001	20170905002
Physical Characteristics							
pH	pH units	U.S.	4.5-8.5	41000	5.40	5.90	5.67
Conductivity	µS/cm	U.S.			1	2	2
Trace Metals (ICP/MS)							
Calcium	mg/L	U.S.	30	41000	0.01	0.02	0.03
Sodium	mg/L	U.S.			0.02	0.06	0.23
Aluminum	µg/L	U.S.			<1	<1	2
Nickel	µg/L	U.S.	300	SWEG&41000	4	5	7
Zinc	µg/L	U.S.	2,000	SWEG&41000	1	<1	2
Silicon (ICP/MS)							
Silicon	µg/L	U.S.			768	690	781
Total Organic Carbon (Sievers)							
Inorganic Carbon	mg/L	U.S.			0.66	1.09	0.72
Organic Carbon	mg/L	U.S.	5 / 3	SWEG / 41000	0.96	1.04	1.01
Semi-volatiles (GC/MS) - Target List							
Methyl sulfone	µg/L	U.S.	1,500,000	**interim SWEG (06-2017)**	108	151	101
Base/Neutral Extractables - EPA 625 List							
Diethylphthalate	µg/L	U.S.			21	<20	<20
Silanols (LC/RI) (R & D Method -NIST traceable standard not available)							
Dimethylsilanediol (DMSD)	µg/L	U.S.	35,000	SWEG	2,700	2,400	1,900
Organic Carbon Recovery	percent	U.S.			77.68	63.80	51.54
Unaccounted Organic Carbon	mg/L	U.S.			0.21	0.38	0.49

Comments: 20170905001 & -002 - *Location not marked on sample bag.

Data Qualifiers: None for parameters listed.

NA=Not analyzed
MI=Matrix Interference
N/A=Not applicable

Table 4: Analytical concentrations of compounds quantified in US Multifiltration Bed effluent, wastewater, and condensate samples returned on SpX-12

Increment			52			
Mission			SpX-12			
Sample Location			WPA MF Bed ORU S/N 00016	WPA MF Bed ORU S/N 00017	WPA Wastewater ORU	WPA Condensate Sample Port
Sample Description		Test Conducted by	WPA MF Bed Effluent	WPA MF Bed Effluent	WPA Wastewater	US Condensate
Sample Date			8/9/2017	8/9/2017	8/11/2017	8/8/2017
Analysis/Sample ID	Units		20170919002	20170919003	20170919004	20170919005
Physical Characteristics						
pH	pH units	U.S.	4.44	4.67	7.21	7.85
Conductivity	µS/cm	U.S.	18	14	122	360
Anions (IC)						
Fluoride	mg/L	U.S.	<0.1	<0.1	0.4	0.4
Cations (IC)						
Ammonia as Nitrogen (NH3-N)	mg/L	U.S.	<0.25	<0.25	12.9	46.7
Trace Metals (ICP/MS)						
Calcium	mg/L	U.S.	<0.05	0.05	<0.05	0.12
Sodium	mg/L	U.S.	<0.05	0.11	<0.05	<0.05
Aluminum	µg/L	U.S.	<5	<5	<5	6
Copper	µg/L	U.S.	17	<5	<5	<5
Iron	µg/L	U.S.	<25	<25	100	<25
Manganese	µg/L	U.S.	<5	<5	216	63
Nickel	µg/L	U.S.	16	23	236	619
Silver	µg/L	U.S.	<5	<5	6	<5
Zinc	µg/L	U.S.	8	11	1,490	5,140
Silicon (ICP/MS)						
Silicon	µg/L	U.S.	4,490	5,180	5,160	19,600
Total Organic Carbon (Sievers)						
Inorganic Carbon	mg/L	U.S.	<3.0	<3.0	9.44	33.2
Organic Carbon	mg/L	U.S.	23.2	19.1	41.9	113
Volatile Organics						
Acetone	µg/L	U.S.	5,300	6,020	5,360	1,710
2-Butanone (Methyl ethyl ketone)	µg/L	U.S.	291	<50	278	<50
Volatile Organics-Special Interest Compounds (Semi-quantitative)						
Trimethylsilanol	µg/L	U.S.	not found	not found	110	260
Volatiles - Non-Targets (GC/MS)						
Dimethyl sulfide (Thiobismethane)	µg/L	U.S.	not found	not found	not found	76
Semi-volatiles (GC/MS) - Target List						
Benzothiazole	µg/L	U.S.	<40	<50	48	40
N-n-Butylbenzenesulfonamide	µg/L	U.S.	<40	<50	54	72
Tris(2-Chloroethyl)phosphate	µg/L	U.S.	<40	<50	104	79
Decamethylcyclopentasiloxane	µg/L	U.S.	<40	<50	<40	53
Dodecamethylcyclohexasiloxane	µg/L	U.S.	<40	<50	<40	39
Methyl sulfone	µg/L	U.S.	148	<50	124	152
Acid Extractables-EPA 625 List						
Benzoic acid	µg/L	U.S.	<200	<250	1,780	1,750

NA=Not analyzed
MI=Matrix Interference
N/A=Not applicable

Table 4 (cont.): Analytical concentrations of compounds quantified in US Multifiltration Bed effluent, wastewater, and condensate samples returned on SpX-12

Increment			52			
Mission			SpX-12			
Sample Location			WPA MF Bed ORU S/N 00016	WPA MF Bed ORU S/N 00017	WPA Wastewater ORU	WPA Condensate Sample Port
Sample Description		Test Conducted by	WPA MF Bed Effluent	WPA MF Bed Effluent	WPA Wastewater	US Condensate
Sample Date			8/9/2017	8/9/2017	8/11/2017	8/8/2017
Analysis/Sample ID	Units		20170919002	20170919003	20170919004	20170919005
Phenol	µg/L	U.S.	<40	<50	228	216
p-Cresol (4-Methylphenol)	µg/L	U.S.	<40	<50	356	25
Base/Neutral Extractables - EPA 625 List						
Benzyl alcohol	µg/L	U.S.	<40	<50	60	2,390
Dibutylphthalate	µg/L	U.S.	<40	<50	81	46
Diethylphthalate	µg/L	U.S.	<40	<50	343	903
Dimethylphthalate	µg/L	U.S.	<40	<50	<40	23
Semi-volatiles (GC/MS) - Special Interest Compounds (Semi-quantitative - 2 pt curve)						
Benzaldehyde	µg/L	U.S.	not found	not found	not found	37
2-Butoxyethanol	µg/L	U.S.	not found	not found	not found	89
2-(2-Butoxyethoxy)ethanol	µg/L	U.S.	not found	not found	450	1,500
Butylated hydroxyanisole (BHA)	µg/L	U.S.	not found	not found	82	99
Caffeine	µg/L	U.S.	not found	not found	not found	38
N,N-Diethylformamide	µg/L	U.S.	not found	not found	not found	50
N,N-Dimethyl acetamide	µg/L	U.S.	400	not found	370	770
N,N-Dimethylformamide	µg/L	U.S.	440	not found	not found	460
Dipropylene glycol methyl ether	µg/L	U.S.	not found	not found	180	400
2-Ethoxyethanol	µg/L	U.S.	280	not found	220	270
2-Ethyl-1-hexanol	µg/L	U.S.	not found	not found	not found	100
2-Ethylhexanoic acid	µg/L	U.S.	not found	not found	not found	88
Ibuprofen	µg/L	U.S.	not found	not found	1,200	not found
p-Menth-1-en-8-ol (alpha-Terpineol)	µg/L	U.S.	not found	not found	not found	33
1-Methyl-2-pyrrolidinone	µg/L	U.S.	not found	not found	210	380
Monomethyl phthalate	µg/L	U.S.	not found	not found	110	260
(+)-Neomenthol	µg/L	U.S.	not found	not found	58	not found
2-Phenoxyethanol	µg/L	U.S.	not found	not found	650	2,600
2-Phenyl-2-propanol	µg/L	U.S.	not found	not found	not found	220
1,3,5-Triallyl-1,3,5-triazine-2,4,6(1H,3H,5H)-trione	µg/L	U.S.	not found	not found	48	100
Tributyl phosphate	µg/L	U.S.	not found	not found	not found	47
Triethyl phosphate	µg/L	U.S.	not found	not found	not found	1,400
Alcohols (DAI/GC/MS)						
Ethanol	µg/L	U.S.	10,400	8,320	19,200	30,000
Methanol	µg/L	U.S.	4,010	3,800	5,960	5,400
1-Propanol	µg/L	U.S.	524	440	<400	<400
2-Propanol (Isopropanol)	µg/L	U.S.	1,360	2,440	428	536
Glycols (DAI/GC/MS)*						
1,2-Ethanediol (Ethylene glycol)	µg/L	U.S.	1,020	1,220	<1000	4,250
1,2-Propanediol (Propylene glycol)	µg/L	U.S.	4,850	3,640	8,640	45,800

NA=Not analyzed
MI=Matrix Interference
N/A=Not applicable

Table 4 (cont.): Analytical concentrations of compounds quantified in US Multifiltration Bed effluent, wastewater, and condensate samples returned on SpX-12

Increment			52			
Mission			SpX-12			
Sample Location			WPA MF Bed ORU S/N 00016	WPA MF Bed ORU S/N 00017	WPA Wastewater ORU	WPA Condensate Sample Port
Sample Description		Test	WPA MF Bed Effluent	WPA MF Bed Effluent	WPA Wastewater	US Condensate
Sample Date		Conducted	8/9/2017	8/9/2017	8/11/2017	8/8/2017
Analysis/Sample ID	Units	by	20170919002	20170919003	20170919004	20170919005
Silanols (LC/RI) (R & D Method -NIST traceable standard not available)						
Dimethylsilanediol (DMSD)	µg/L	U.S.	17,000	19,000	17,000	65,000
Carboxylates (IC)						
Acetate	µg/L	U.S.	6,340	4,690	<500	9,170
Formate	µg/L	U.S.	<500	<500	3440	<500
Glyoxylate	µg/L	U.S.	<500	<500	<500	729
Propionate	µg/L	U.S.	964	<500	<500	<500
Aldehydes						
Formaldehyde	µg/L	U.S.	<20	<10	<20	23
Organic Carbon Recovery	percent	U.S.	96.24	106.15	71.52	64.36
Unaccounted Organic Carbon	mg/L	U.S.	0.87	0.00	11.93	40.27

Comments: *Glycols were performed by GC-FID R&D method.

Data Qualifiers: 20170919002 - Possible low bias Fluoride.
20170919004 - Possible low bias Acetone.
20170919005 - Possible high bias - Methanol.

NA=Not analyzed
MI=Matrix Interference
N/A=Not applicable